The development of gesture

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Human beings gesture everyday while speaking: they move their hands, their heads, their arms; their whole body is involved in communication. But how does it work? How do we produce gestures and in what purpose? How are gestures connected to speech? When do we begin producing gestures and how do they evolve throughout the life span? These are questions gesture researchers have been trying to answer since the second half of the 20th century.

This chapter will first define what a gesture is by describing the different kinds of gestures and by explaining some of the current theories about gesture production. Then, the emergence of gesture along with language development will be exposed as well as its evolution during childhood. Finally, we will review studies about adults' gestures and what we know about their change across adulthood.

1 What is a gesture?

At first, gesture may seem easy to define: a movement of the hand or maybe of both hands produced by a human being. However, when one thinks more precisely about it, one may wonder if a gesture is only performed with hands or if it can involve other body parts such as head, face or arms. One can also wonder if there are different kinds of gestures: are nervous scratches, gestures accompanying speech and gestures used in deaf sign language the same kind of movements? Indeed, even if there are all called gestures, they differ. This first section will give a brief overview of the various types of gestures and of the main issues in gesture studies.

1.1 What is a communicative gesture and what is not

If we look at two persons involved in a face to face interaction, we will notice that they move their body continuously. One of the participants may be performing practical actions such as taking notes, smoking, driving, etc: these are not considered as communicative gestures. Similarly non verbal behaviour such as postures, crossing

the legs and nervous gestures like scratching, play with an object, stroke the hair are not regarded as communicative gestures either. Nevertheless, these movements can have an impact on the interaction. For instance, if one nervously plays with a pen or taps on the table with their fingers, their addressee might end the conversation earlier than planed. Thus, as Adam Kendon puts it (2004:8) "usually 'gesture' is not used to refer to those visible bodily expressions of thoughts or feelings that are deemed inadvertent or are regarded as something a person cannot 'help'". A gesture is rather considered as intended to communicate something. Now that we have put aside what movements are not regarded as gestures, we are left with the idea that a gesture is an action related to ongoing talk and that has the features of manifest deliberate expressiveness (Kendon, 2004). This includes a whole range of movements such as a thumb up for OK, a finger pointing to a place or an object and even a gesture of sign language. Researchers have proposed several classifications of these gestures in order to differentiate them. Classifications can rely on semiotic or functional distinctions, sometimes a mix of both (for an overview of the various classifications, see Kendon, 2004, chap. 6). A very efficient and practical classification is called Kendon's continuum and will be detailed below for it is nowadays commonly used to explain the different kinds of gestures.

1.2 Kendon's continuum

Based on Adam Kendon's work (1988), Kendon's Continuum has been elaborated by David McNeill (1992 and 2000). McNeill placed on a continuum four kinds of gestures: gesticulation, pantomime, emblems and sign language. Gesticulation refers to "idiosyncratic spontaneous movements of the hands and arms accompanying speech" (McNeill, 1992: 37), they are also called co-speech gestures and will be detailed below. Pantomime is used to define those gestures that mime an action or an object, a profession, etc. and that are mainly used when it is impossible to speak (because of the noise, distance, need to be discreet…) or in games of miming. Emblems are conventionalised gestures used in a specific community, they have a defined meaning. For instance, the thumb up meaning OK in some countries such as the USA or the forefinger pulling down the skin under the eye and which means in the French culture: I don't believe it ("Mon oeil"). Emblems are most of the time associated with a fixed expression but can be used without speech. People belonging

to a same cultural community understand these gestures because they have learned them along with their first language. Eventually, sign languages are "full-fledged linguistic systems with segmentation, compositionality, a lexicon, a syntax, distinctiveness, arbitrariness, standards of well-formedness, and a community of users" (McNeill, 1992:38). Indeed, sign languages (no matter if they are languages used by the deaf or ritual and cultural languages used by the North American Plain Indians or by Central Australia Aborigines, for instance) are languages of their own and are mainly used without speech.

Originally, McNeill (1992) organised these four kinds of gestures on a continuum according to their link to speech and to their degree of convention. Thus, on the left hand side, gesticulation is made of gestures that require the presence of speech whereas on the right hand side, sign languages are used without speech. On the left hand side, gesticulation is made of spontaneous idiosyncratic gestures and on the right extremity, sign languages are strongly conventionalised and socially regulated signs.

Gesticulation ⇨ Pantomime ⇨ Emblems ⇨ Sign languages
Obligatory presence of speech ←----------→ absence of speech
Not conventionalised ←----------→ conventionalised

In 2000, McNeill enriched this continuum by dividing it into four continua by using the original characteristics "relationship to speech" and "relationship to conventions" and by adding other characteristics such as "relationship to linguistic properties" and "character of the semiosis". The four continua are described as follows:

Continuum 1: relationship to speech

Gesticulation ⇨	Emblems ⇨	Pantomime ⇨	Sign Language
Obligatory presence of speech	Optional presence of speech	Obligatory absence of speech	ditto

Continuum 2: relationship to linguistic properties

Gesticulation ⇨	Pantomime ⇨	Emblems ⇨	Sign Language
Linguistic properties absent	Ditto	Some linguistic properties present	Linguistic properties present

Continuum 3: relationship to conventions

Gesticulation ⇨	Pantomime ⇨	Emblems ⇨	Sign Language
Not conventionalised	Ditto	Partly conventionalised	Fully conventionalised

Continuum 4: character of the semiosis

Gesticulation ⇨	Pantomime ⇨	Emblems ⇨	Sign Language
Global and synthetic	Global and analytic	Segmented and synthetic	Segmented and analytic

1.3 Types of co-speech gestures

Many gesture researchers have decided to focus on the study of co-speech gestures also called 'gesticulation' in Kendon's continuum. They are movements of the hands and arms produced by people when they talk. They do not belong to a fixed repertoire as gestures of sign language for instance, on the contrary, they are unique, personal and spontaneous. As mentioned before, there are several classifications of gestures, most of them descent from Efron's (1941/1972) such as Ekman and Friesen's (1969). Although they are relevant and fine classifications, Efron's as well as Ekman and Friesen's are extremely detailed and not always easy to use. That is why David McNeill and his team (1992) have worked on a simplified, easy to use scheme made of four categories: iconic, metaphoric, deictic and beats.

Iconic gestures bear a close formal relationship to the semantic content of speech (McNeill, 1992). For instance, someone may say “I was driving when I heard the news on the radio” and mime holding a steering wheel while saying “drive” or if someone says “It was as big as that” while showing a width with both hands open and facing. “Most of the time, iconics represent body movements, movements of objects or people in space, and shapes of objects or people. They do so concretely and relatively transparently” (Goldin-Meadow, 2003: 7).

Metaphoric gestures are very similar to iconics except that they depict abstract concepts rather that concrete objects. If one cups their hands when saying the word “concept” for instance, it is a metaphoric gesture because the cup acts as a symbolic image for the idea of a concept.

Deictics gestures refer to things by pointing with the hand, the finger, the chin, etc. They can be either concrete pointing to someone, something or somewhere, like when one says “your glasses are here on the table” while point towards the table and the glasses. But it can also be abstract pointing when referring to something/someone absent or a place or even a moment in time, like for instance, one points to the right to mean China or in their back to refer to the past. Abstract deictics can be shaped by

cultural characteristics as geographical and time references differ between languages and cultures.

Finally, beats are rhythmic movements that have no semantic connexion to the speech they accompany. They rather stress important words or phrases. A typical beat would be a flick of the hand or of the finger. McNeill (1992) explains that the critical thing distinguishing beats from other gestures is that it has two movements phases-in/out, up/down, etc.

1.4 What we know about gesture production

1.4.1 The relationship between gesture and speech

Gesture and speech are considered by most of the gesture researchers as being part of one single system (McNeill, 1992) that is why they should not be analysed separately.

There are two arguments to support the theory of the speech-gesture unified system. The first argument is that there is strong semantic coherence between the two modalities in an utterance. According to McNeill (1992) gesture and speech form a unified communication system and the coherence is possible because gesture and speech share a common cognitive representation, they are part of a single idea. When a speaker produces a message, most of the information s/he wants to share is conveyed in speech while part of the information may be channelled through gesture. However, gesture and speech convey information from different perspectives. In short, speech conforms to a codified, restricted and recognizable system of words and grammatical devices whereas gesture is free from the standards of form language imposes and conveys meaning on a rather global and visual basis (Goldin-Meadow, 2003). With gestures, one can describe shape, motions or size far more easily than with words. Most of the time, information conveyed through gestures is visual imagery.

Because they are so different, gesture and speech when both implied in the same message do not always bring the same information. Church and Goldin-Meadow (1986) talk about gesture-speech matches when gesture is elaborated on a topic already introduced in speech and gesture-speech mismatches when gesture introduces new information not conveyed in speech. It is thus not rare in a message

that gesture brings information that completes speech. For instance, a woman saying "she chases him out again" (talking about an old lady running after a cat) and moving her hand back and forth revealing that she uses her umbrella as a weapon (McNeill, 1992). In this example, the gesture provides us with information not conveyed in speech and shows us how much gestures can describe things speech cannot. Gesture is not restricted to a fixed form and can vary on several dimensions such as time, form, motion, trajectory, use of space, shape, rhythm, etc. which make it complex.

The second evidence that gesture and speech form a unified system is that they are always synchronous. McNeill (1992) found that 90% of gestures where produced while the gesturer is speaking. It has also been found that gesture and speech are co-temporal in a single utterance: the stroke of the gesture lines up with the linguistic equivalent.

1.4.2 Why do we produce gestures?

A first answer to this question could be: to help our listeners to understand what we say. Indeed, Alibali *et al.* (2001) have found that people gesture more when talking to a visible interlocutor and that when they talk to someone hidden behind a screen, they tend to use less illustrative gestures. Several other studies have come to similar findings (for a review, see Alibali *et al.*, 2001 and Özyürek, 2002).

Özyürek (2000 et 2002) explored the communicative function of gesture by analysing how speakers design their gestures according to the location of their addressees. She found that speakers oriented their gestures depending on where their interlocutors were sitting so that gestures could be seen.

In order to find out whether gestures were taken into account by the listeners, Kelly and colleagues (1999) analysed the role of deictic gestures on the understanding of indirect questions like saying "It's hot in here" while pointing to the window, inferring that the listener should go and open it. Results show that deictic gestures help listeners to understand better the hidden intention in the speaker's message. Beattie and Shovelton (1999) showed that subjects listening to someone telling a story understand significantly more details when they see the speaker (and their gestures) than when they do not. Listeners also take into account information conveyed in gesture when it completes or contradicts speech (Cassell *et al.* 1999).

However, even if gesture helps listeners to better understand a conversation, it seems that it is not the main function of gestures. Indeed, in the study of Alibali *et al.* (2001) already mentioned, even if speakers produced less gestures when they did not see their interlocutors, they still gestured. Moreover, Iverson and Goldin-Meadow (1998) have laid evidence that congenitally blind speakers spontaneously gesture even when they speak to blind listeners. Thus we can assume that gesture does not solely convey information for the listener but also plays a role for the speaker. This can also explain why we gesture when we talk on the telephone, for instance.

So, if we produce gestures for ourselves, what is the function of gesture in speech production? There are several theories on this topic.

The Lexical Retrieval Hypothesis (LRH) holds that gesture plays an active role in lexical access, particularly for words with spatial content (Rauscher, Krauss & Chen, 1996). Thus gesture plays a role in generating the surface forms of utterances, it infers directly in the process of speaking. Alternatively, the Information Packaging Hypothesis (IPH) (Alibali *et al.*, 2000 ; Kita, 2000) is drawn from McNeill's (1992) and McNeill & Duncan's (2000) theory of gesture and speech as an integrated system (Growth Point). It argues that gesture and speech help to constitute thought and that gestures reflect the imagistic mental representation that is activated at the moment of speaking. In order to find out which theory (LRH or IPH) is likely to be true, Alibali *et al.* (2000) gave five-year-olds two oral tasks: one was a description task (children had to describe different objects) and one was an explanation task (Piagetian conservation task like, for instance, judging whether two different recipients content the same amount of sand). Both tasks required similar lexical use (same objects to talk about) but inferred different cognitive conceptualisations (one being description and the other explanation). According to the LRH, subjects should use the same gestures in both tasks since they roughly need the same lexical items. Conversely, according to the IPH, as conceptual planning is different in both tasks, gestures should be different. The hypothesis is that if children use different gestures in both tasks while using similar words, then gestures do not only help to retrieve words but also to organise thought and conceptualise the message to be verbalised. Results show that, indeed, in the explanation task (more demanding cognitively), children used more gestures conveying perceptual dimensions of the objects and more gestures conveying information that differed from the accompanying speech. Thus,

gesture helps cognitive activity. Alibali *et al.* (2000) conclude that "The action of gesturing helps speakers to organise spatial information for verbalisation, and in this way, gesture plays a role in conceptualising the message to be verbalised." (Alibali *et al.* 2000: 610). However, even if data tends to favour the IPH theory, the authors do not reject the LRH and admit that gesture helps both lexical retrieval and organisation of spatial information for verbalisation.

One last noticeable element on gesture and production is that it has been found that preventing subjects from gesturing has an effect on speech, for instance, in a description task, gesture-restriction has an effect on the amount of time needed to describe an object (Cohen and Borsoi, 1996) and it also generally decreases speech rate (Morsella and Krauss, 2004).

2 Gesture development in childhood

The first communicative gestures appear at a very early age. Many researchers have analysed them and their occurrence with speech. It seems that gesture plays a crucial role in transitional knowledge.

2.1 What we know about gesture development in childhood

From the age of 10 months, babies begin to produce some kind of gestures like pointing, giving, showing (Bates *et al.*, 1979 ; Van Der Straten, 1991). They repeat behaviours that they know will catch adults' attention. Deictic gestures or pointing which rapidly increase at the end of the first year of age, are considered by psycholinguists as prelinguistic gestures for they constitute an important stage in the development of speech. Pointing, accompanied by eye contact with an adult, aims at seeking information or approval and acts as a precursor to spoken and sign naming. Indeed, the sequence of deictic gesture development reveals the gradual distancing self from object that underlies symbolic development (Capone and McGregor, 2004). The child points to an object not to request it but to refer to it, it reveals that the child can isolate an object from the rest of his/her environment as s/he will soon do with words that will be isolated from the flow of speech the child is exposed to. The ability to decontextualise is crucial as is it related to the ability to use a word in the absence of the referent or to use it with other exemplars of the same referent. In the period between 9 and 13 months also ritualized requests appear like open-close grasping motions or pulling an open hand to obtain something (Bates *et al.* 1979).

Representational gestures begin to emerge around the age of 12 months before the onset of the 25-word milestone. These are not instrumental gestures for the infant does not manipulate objects but rather represents referents symbolically. For instance, the child represents the action of holding a glass and drinking or flap his/her arms to represent a bird. Goodwyn and Acredolo (1993) consider that these representational gestures are real examples of language symbols and can be analysed with the same criteria used to define spoken words. They argue that a gesture or a word is symbolic if it refers to multiple examplars including pictures and absence of the referent, if it is produced spontaneously (without following the model of an adult) and if it is not part of a well rehearsed routine (Goodwyn and Acredolo, 1993)

Between 12 and 18 months, the child gestures in an isolated way which means that s/he either gestures or speaks but hardly both in the same time. The child thus chooses between the two systems s/he knows (McNeill, 1992). Iverson *et al.* (1994) found that 16-month-old children have a preference for either words or gestures, but by 20 months, there is a significant increase in types and tokens of spoken words.

As we have already stated, gesture and speech in adults seem to belong to a single system (McNeill, 1992). This hypothesis is supported by two characteristics: the integration of gesture and speech in a semantic coherence (the fact that gesture is combined with speech in a meaningful way) and the temporal synchrony between speech and gestures in a single utterance. But is that also true for young children? Is gesture-speech integration characteristic of the earliest communications of young children? Or does integration of the two modalities emerge at a consistent point in the young child's linguistic development? (Butcher and Goldin-Meadow, 2000) To answer these questions, Butcher and Goldin-Meadow (2000) have longitudinally observed three boys and three girls during the transition from one– to two-words speech. They started to video-tape their subjects during play sessions when they were beginning their one-word period of language development (age range 12 to 21 months, mean 15.5 months) and until the stage of two-word combination (range from 18 to 26.5 months). During the one-word-period, for 5 of the 6 children, 20% of the total number of their communications (speech and/or gesture) included a gesture (for the 6th child, it was approximately 40%). During the first session, data uncovered that most of the subjects (5 out of 6) produced the majority of their gestures without speech (to compare, McNeill, 1992, has found that only 10% of adult's gestures are

produced without speech). Then, during the following sessions, a general decline in the proportion of gestures produced without speech was observed. Thus, children began the one-word period producing gestures without speech and, by the end of this period, they mainly used gesture-speech combinations.

The two characteristics of adults' productions of speech and gestures are the synchrony of both modalities and the semantic coherence. Consequently, Butcher and Goldin-Meadow (2000) observed if children's productions of speech and gestures bear these same characteristics. As far as synchrony is concerned, during the first session, 5 of the 6 children produced gesture-speech combinations that were not synchronous with speech (the 6th child produced synchronously timed combinations throughout the observation period). During the next sessions, combinations became more and more harmonious. The authors thus suggest that "gesture and speech do not form a completely integrated system from the start but may require some time to become aligned with one another." (Butcher and Goldin-Meadow, 2000: 246). As far as semantic content is concerned, McNeill (1992) discovered that gesture and speech "cover the same idea unit" (1992: 27) even if gesture and speech do not convey precisely the same information. When analysing the gestures combined with meaningful words produced by their children, Butcher and Goldin-Meadow (2000) found that the number of gesture-speech combinations increased during the observation period. The children produced both occurrences of gesture conveying the same information as speech (point to the box and say "box") and occurrences of gestures conveying different but related information (point to the box and say "open"). In this later case, the child can express two different elements in a single utterance (one in gesture and one in speech), something s/he is not yet able to do in speech only. "Thus the ability to combine gesture and meaningful speech in a single utterance greatly expands the child's communicative range." (Butcher and Goldin-Meadow, 2000: 248).

By putting together all theses findings, the authors highlighted the striking fact that the three events converge in time: gesture-alone communications began to decline and "synchronous gesture-speech combinations began to increase at just the moment when gesture was first combined in the same utterance with a meaningful word" (Butcher and Goldin-Meadow, 2000: 248). To sum up the observed developmental sequence, the child begins to produce communicative symbolic

gestures mostly without speech, when it is combined with words it occurred that speech was meaningless and gesture was not synchronised with it. Then, gesture and speech become more fully integrated and the child begins to produce synchronised combinations of gestures and meaningful words. This is the beginning of gesture-speech integration as we find it in adult's expression. Butcher and Goldin-Meadow (2000) explain that the emergence of combinations in which gesture and speech are semantically related but do not convey the same information represents a communicative, even conceptual, breakthrough for the child and announces the onset of two-word speech. Indeed in the six children observed, the correlation between the onset of this type of gesture-speech combinations and the onset of two-word utterances is high and reliable.

During toddlerhood, children come to prefer verbal to gestural expression as they are learning more and more words. However, children still use gestures and there is a certain increase in the use of deictics particularly accompanying expressions such as "this" and "that" (Iverson *et al.*, 1994). In the second and third years of life, pointing becomes increasingly integrated with spoken language particularly to supplement spoken messages (Iverson *et al.*, 1994). From 16 to 20 months, there is a significant increase in pointing gestures co-occuring with representational words. As speech develops, gestures become more and more elaborated, especially in their relation to speech. Iconics tend to appear more and more with verbs and adjectives, rather with nouns and the relationship between gesture and language extends to the domain of morphosyntax as the children advance in these areas (Capon & McGregor, 2004).

Between the third and the fifth year of age, iconic gesture increase significantly. Iconics and speech become more and more synchronised. Nevertheless, children's co-speech gestures do not yet refer to abstract contents, metaphorics are hardly found in young children's gesture productions. From the age of 5, the rest of the gestural system develops and beats, metaphorics as well as abstracts deictics become more and more numerous (McNeill, 1992).

Colletta (2004) has conducted a vast quantitative study on the development of verbal and non verbal activity of children from 6 up to 11. He confirms McNeill's findings as far as the emergence of metaphorics and beats is concerned (after the age of 5/6). He also found that multimodal story-telling skills (linguistic, prosodic and

gestural) develop together and simultaneously. Colletta also showed that the study of co-speech gestures enables researchers to gather clues and relevant information on the development of concept and mental imagery of children. As children grow older and develop, gestures develop too and appear in cognitive tasks very often, allowing researchers to better understand how the child acquires concepts.

Studying the matches and mismatches in speech and gestures produced by children proves to be very relevant when one tries to understand their cognitive development (Goldin-Meadow, 2003). It appears that when some children explain something they have not yet understood (a math concept, for instance), they tend to convey the same incorrect information both in gesture and speech, in a single procedure, so to speak. They then enter a discordant state in which they produce different procedures: one in speech and another in gesture. It means that the child is in a zone of proximal development. The information expressed in gesture is different from the one expressed in speech. Most of the time, accurate information tends to be the one conveyed in gesture. Then, when the concept is acquired by the child, gesture and speech match again in the child's production (Alibali & Goldin-Meadow, 1993). This transitional state is thus characterised by the concurrent activation of more than one procedure, and provides further evidence that gesture can be a powerful source of insight into the processes involved in cognitive development. This phenomenon has been noticed for math and science concepts but is probably applicable to other general concepts. Therefore, gesture has a direct effect on the learning process and scaffolds the child's cognitive development by structuring the various stages of the acquisition of a concept or a skill.

As we have seen, the analyses of the gestures produced by a child can reveal stages of transitional knowledge. The first deictic gestures announce the emergence of the first words. Then the combinations of gesture and speech conveying different but related information precede the first two-word utterances. And finally, as the child develops, it seems that complex concepts emerge in gesture before they appear in speech (or in speech combined with gesture). Globally, gesture-speech mismatches occur in a wide variety of situations and at different ages, from childhood to adulthood (for a review, see Goldin-Meadow, 2003). The study of gesture-speech matches and mismatches offer a window to the mind of the developing child and of the teenager. Goldin-Meadow (2000: 237) suggests to look "beyond children's words

to the secrets that, until now, have been locked in their hands" to discover more about children's learning.

2.2 For further research

As far as development of the gestural system is concerned, most of the studies concern very young children who are acquiring their first language. Consequently, less attention has been devoted to older children and how they develop their way of gesturing while acquiring new discursive skills. Colletta's study (2004) is thought worth mentioning since it concerns gesture development between 6 and 11 years old. Gestures of children after 11 and of teenagers have not been much studied. This is perhaps due to the fact that most of the first language is acquired and that significant changes are very slow to occur. However, it seems relevant to study how a teenager develops his/her own style of gesturing at this particular period of self constructing. The way somebody gestures depends on many factors (detailed in the next section) among them personality. Teenagers may also be influenced by fashion in their way of gesturing. Gestures used by rap signers for instance seem to influence young individuals especially boys. Gender is a factor which seems worth studying as well. Whether boys and girls gesture the same way is something left to discover.

Research on gestures and children is, as we have seen, relevant to understand how a child acquires a first language and how gestures participate to the cognitive development. These researches have implications in the field of education. For instance, it seems relevant to work on gestures children look at when they learn and in the field of education this means teachers' gestures. Singer and Goldin-Meadow (2005) have laid evidence that teachers' gesture do not always convey the same information as their speech. This mismatch thus offers learners a second message (one conveyed by gesture and the other by speech). To determine whether learners take advantage of this offer, Singer and Goldin-Meadow gave 160 children in the third and fourth grades instruction in mathematical equivalence (for example: "6+4+3=_+3". Children were taught either one or two problem-solving strategies in speech accompanied by no gesture, gesture conveying the same strategy, or gesture conveying a different strategy. Chosen strategies are commonly used by teachers when teaching mathematical equivalence, there are "(a) equalizer, a strategy highlighting the principle underlying the problem, and (b) addsubtract, a strategy

highlingting a procedure for solving the problem"(2005: 86). Results show that the children were likely to profit from instruction with gesture, but only when it conveyed a different strategy than speech did. Moreover, two strategies were effective in promoting learning only when the second strategy was taught in gesture, not speech. They conclude that gesture has an active hand in learning (Singer and Goldin-Meadow, 2005). In the field of second language teaching to young children, it has also been found that teachers' gestures help children to better understand the second language without translation. They also help the child to remember L2 lexical items better when s/he visualise an illustrative gesture while listening to the matching word. Data has also shown that children who reproduce their teacher's gestures while repeating new L2 words significantly remembered more items than those who just look at them (Tellier, 2006).

However, one may wonder whether a child always understands adult's gestures since gestures reflect mental imagery and since adults' and children's mental imagery differ due to their different cognitive states and experiences of life. Adults tend to use a lot of metaphoric gestures that may not be understood by young children since they do not use such gestures and do not represent the world in a abstract and symbolic way. Misunderstandings of adults' gestures by 5-year-old children have been found (Tellier, 2006) but more data is definitely needed on this topic and with various age ranges to help teachers think about how they can improve their teaching gestures.

3 Gesture development in adulthood

If many researchers work on the development of gestures during childhood, there seems to be very few studies on this development during adulthood. Studies on development focus essentially on acquisition and decline, e.g. loss of language and language related gestures. However, we can also notice some temporary changes due to change of jobs or related to the belonging/the integration to a specific community One explanation for this lack of studies may be that development is adulthood is much slower than in childhood. Therefore it would take longitudinal studies of several years to notice changes in the development of a single subject whereas children change so quickly that studying a child during a few month's period is enough to notice and analyse the changes in both his/her speech and gesture skills. This is probably why most studies concerning adults are comparative studies in which

subjects of different age groups are given the same task so that results can be compared according to the age variable. Another explanation for the rarity of studies on adults is that interest is rather focused on childhood when most of the development takes place. However we cannot assume that gesture production does not change across the life span once an individual has reached the stage of adulthood. In this section we will review the studies on adults and the evolution of their gestures across the life span and we will expose what research needs to focus on in the years to come.

3.1 What we know about gesture development in adulthood

3.1.1 Different adults, different ways of gesturing

Most branches of psychology examine how subjects behave in different settings or under various experimental conditions assuming that they will behave/react the same way (Cooper, 1998/2002). However, there is significant variation between people and this is true at any age. Some children for instance develop quicker than others and they grow up to develop different personalities and mental abilities. Therefore, adults have to be considered as different human beings and the way somebody gestures is very specific. We can try to figure out which parameters can influence the way somebody gestures.

Every human being is brought up in and belongs to a certain community that will influence both his/her development as a child but also the adult s/he will become. A variable such as the cultural origin has a crucial effect on someone's gestures. First, the emblems someone uses reveal his/her belonging to a certain cultural background for they are, as mentioned before, culture-specific (Morris *et al.* 1979). However, we also know that more spontaneous forms of gestures can also bear cultural characteristics though there are few studies on the subject. David Efron (1941/1972) studied the gestures of both Jewish (from eastern Europe) and Italians immigrants freshly arrived in New York city and was able to compare them to members of the same ethnic groups but who were more assimilated to the American culture. He noticed significant differences between the "traditional" southern Italians and the "traditional" eastern Jews on different basis: the use of the gesture space (wide gestures or close to the trunk), the body parts implied in the gestures (the forearms or the whole arms, for instance), the gesture tempo, etc. For example, Efron

found that the traditional Italians gesture in a wider radius than the traditional Jews. Also, the Jews seem to axe theirs gestures from the elbow while the Italians' axis of movement is rather from the shoulder. Efron also found out that Jews rather gesture with one arm or when they use both they tend to move them in an asymmetric way. On the contrary, the Italians are more likely to gesture with both arms and in a symmetric way. A last example taken from the many differences observed is the use of symbolic gesture which is really more important in the traditional Italian community. These findings show that there is an effect of the cultural variable on the way people gesture.

Efron also found far less differences between the "assimilated" Jewish and Italian communities whose ways of gesturing resembled those of the Anglo-Saxon speakers. We may infer from this finding that our gesture style can be influenced by other cultures when we have a long contact with them.

Connected to cultural origin, one's first language is also known to have an impact on the production of co-speech gestures. Linguistic structures vary from one language to the next (Talmy, 1985) and so do gestures. For instance, data has shown that Dutch, French and Swedish native speakers give more importance to verbs and actions in a sentence than Japanese who rather stress the location and the settings for actions. Consequently, co-speech gestures produced by Dutch, French and Swedish speakers appear along with verbs whereas Japanese's gestures provide information on the setting of the action (Yoshioka, 2005, Gullberg, 2006). Thus, speakers of various languages differ in the way they verbally describe motion events and space and so do their gestures as McNeill and Duncan (2000: 154) put it about English, Spanish and Chinese: "Describing the same motion events, languages encourage different forms of thinking. English and Spanish (…) are predicative in their focus, but thinking differs in how motion-events semantics are focused. Chinese induces thinking in which a focus is a frame for other information. Observations thus show an effect of linguistic organization on thinking on two levels –predicative and discourse- and different patterns on both." (See also Kita and Özyürek, 2003).

Every human being also belongs to a certain social origin which has probably an effect on the gesture style (Calbris and Porcher, 1989) though it seems that there are hardly any studies on the subject. We nevertheless know that some gestures or ways

of gesturing are considered rude for certain social classes and others are considered posh or even ridiculous by others. There is clearly a need for data on this variable.

We have just examined how the cultural, linguistic and social background of an individual can affect the gesture style and reveal the belonging of this person to a cultural/linguistic/social community. If we want to go further on differences, we have to remember that each community is composed by a group of individuals whose gestures are shaped by a certain combination of variables.

A first variable is gender though we do not have much information on how gender affects gestures for there does not seem to be any systematic measurement of differences as far as co-speech gestures are concerned. However, studies in non verbal communication have shown differences such as the way arms and legs are displayed, the way people sit, stand or walk. Even the way, they carry books can vary depending on gender. These differences seem to appear during childhood then develop and increase with age (see Rekers *et al.*,1981, for a review). However there might be a difference between men and women as far as co-speech gestures are concerned since it is sometimes said about some men that they are effeminate and this assumption is based on their gestures. Sexual orientation could be a factor influencing the way somebody gestures, research on this issue could give us more information on gender and gesture styles.

There are other variables that may influence gestures like personality, for instance. How personality can affect non verbal behaviour has been studied (see Feyereisen and de Lannoy, 1985, for an overview) but there is little work done on hand gestures specifically. The effect of mental health and some specific psychological disturbances on gesture has also been analysed and it has been shown that depressive people tend to produce more self-touching gestures and that schizophrenics use more speech-related gestures. These gesture rates are likely to change along with the amelioration or deterioration of the mental health condition (Freedman and Hoffman, 1967; Freedman, 1972).

Verbal skills and the level of proficiency in the language can also have an effect on the way someone gestures. This is true both for first and second language acquisition. In both cases, the lower the proficiency, the greater the number of gestures. As we have already mentioned, when children acquire their first language, their gestures are not replaced by speech, but develop in parallel to it. As for second

language acquisition, data has shown that learners produce more gestures when speaking in their L2 than in their L1 (Gullberg, 1998, Sherman and Nicoladis, 2004, Yoshioka, 2005). For adult L2 learners, gestures tend to be complementary from the beginning, "complementary strategic gestures serve both to elicit responses from listeners and to create redundancy." (Gullberg, 1998: 230). Also, in cases of disfluency and depending on the type of difficulty, L2 learners tend to use compensatory gestures. Indeed, as Gullberg (1998) has shown, they use gestures as communicative strategies to overcome expressive problems such as lexical shortcoming, grammatical difficulties and fluency-related problems.

To find out how gestures can change in connection to language development, it is very relevant to work with adult subjects learning another language. As stated above, studying co-speech gestures can give us hints on the specific linguistic organisation of each language. Therefore, two languages with different linguistic conceptualisations might lead to different gestures. Current research on gestures and L2 acquisition is analysing how a learner acquires a target language by observing his/her gestures with the assumption that if the learner has acquired the L2 conceptualisation then his/her gestures should look L2-like (Gullberg, forth.).

Finally, professional skills can have an effect on the gesture style, especially when a profession deals with rhetoric. Some studies on politicians (Calbris, 2003) and on second language teachers (Tellier, 2006, Cadet & Tellier, 2007) have highlighted the specificity of gestures produced intentionally for a large audience and in order to stress and illustrate major information. Empirical studies and observations aiming at showing how the development of professional skills can influence the way people gesture are definitely needed.

3.1.2 Gesture development and aging

When looking at the scientific literature concerned with body movements and aging, one can notice that there is little work on spontaneous co-speech gestures and that there are a few studies on non verbal behaviour and how aging affects it. As already stated, this can be explained by the fact that longitudinal studies are difficult to set up and maybe also by a lack of interest from researchers. It is also important to mention that there is a practical reason for studying young adult subjects rather than old. In a lot of studies conducted in universities, local students often act as subjects

for it is, of course, very convenient to work this way. This, therefore, raises the question of the diversity of subjects of many studies who are, most of the time, under 25.

Most of the available data concerning body movements and aging was collected in non verbal communication studies, especially about the expression of emotions. This field of research has been particularly interested in how subjects perceive other people's emotions on the basis of non verbal cues. Studies exploring age-related differences in the perception of emotions from facial and vocal cues have found some evidence for age-group differences. Declines in the experience of emotion are more reliable for negative than for positive emotions (Montepare *et al.*, 1999). It has also been found that older subjects seem better at identifying the facial expression of similar-aged peers than of younger adults, as uncovered by Malatesta *et al.* (1987).

Are there any age effects in the production of spontaneous hand gestures? Cohen and Borsoi (1996) have tried to answer this question by looking at what they call "descriptive speech gestures" (or representational gestures, linked to the verbal content) and at "non-descriptive speech gestures" (or non representational gestures, connected to the flow of speech but which do not carry any part of the message) produced by different age groups in a descriptive communication task. They rely on previous comparisons of elderly adults with young adults on cognitive tasks which indicate that the elderly may suffer from a production deficiency. They also rely on the fact that gestures reflect difficulties in the verbal speech system and that gestures are produced in attempt to compensate for language problems. They base this assumption on the findings of Marcos (1979) and Feyereisen (1983). Marcos found that bilinguals used more gestures when speaking their weaker language and Feyereisen highlighted the excessive use of gestures by aphasic subjects. Therefore elderly subjects are expected to compensate for relatively weak verbal communication skills by producing more gestures than young adults (Cohen and Borsoi, 1996). Similarly to Marcos' (1979) findings, they also expect older adults to use more non representational gestures than representational gestures.

In a description task, Cohen and Borsoi (1996) asked 24 female undergraduates (age mean 19.92) and 24 female attending Retirement courses at the university (mean age 69.42) to describe objects. They compared the subjects' oral performance on the basis of the amount of time used for each description, the quality of the object

description and the rate of representational and non representational gestures. They found no significant age effect neither for the description time nor the quality of object description. Thus neither the compensation nor the production deficiency approach received support from their data. However, they found a significant age effect on the rate of representational gestures. Younger female subjects used significantly more representational gestures when describing objects than older ones. There was no difference in the use of non representational gestures. Consequently, the expectation that difficulties in verbal description would be compensated by an increase of the use of gestures by older women was not fulfilled (Cohen and Borsoi, 1996: 53).

In another similar experiment, Cohen and Borsoi (1996) added an extra within-subjects variable: gesture-restriction. Data uncovered an overall effect of the gesture suppression variable: time description was significantly longer in the suppressed condition (a finding later confirmed by Morsella and Krauss (2004) who found that gesture-restriction decreased speech rate). However this variable did not significantly interact with age. Moreover, neither age nor suppression variables affected the quality of verbal descriptions in a significant way. Once again, Cohen and Borsoi (1996) only noticed a significant age effect on the rate of representational gestures (and not on the rate of non representational gestures).

In both experiments of Cohen and Borsoi (1996) the elderly women tended to take longer for their descriptions than the younger female subjects, however this was not significant in the data due to large variation. No age effect on the quality of the descriptions was found. Data showed a significant age effect only on the types of gesture produced. Indeed, younger subjects significantly produced more representational gestures than older subjects. The authors suggest that this difference may be due to the fact that elderly people appear to be less involved with visual images than young adults (Fein *et al.*, 1985) and that the production of representational gestures tends to be driven by a visual or visuomotor imagery system. Thus, this may explain why young subjects produced more representational gestures because they refer to more visual images. The authors conclude that further experiments are definitely needed on this topic. Studies could, for instance, involve male subjects to find out if there is a significant gender variable and be based on another task to check if the observed age difference is task-related. Also the

hypothesis of the variation in the use of visual images should be further explored. Indeed, several studies have tried to find out whether the ability to generate visual images declined with age. A study by Dror and Kosslyn (1994) in which subjects had to imagine things and press keys accordingly to their visual representations showed that older subjects were slower and less accurate in performing the task than younger subjects. Nevertheless, these could be explained by a general slowing and reduced efficiency due to age. This is supported by other experiments involving visual imagery and different age groups and showing no effect of the age variable (see Feyereisen and Havard, 1999, for a review).

Feyereisen and Havard (1999) tried to find out whether different kinds of speech-related gestures depend on the same system or on different subsystems, which means to evaluate McNeill's (1992) theory that all kinds of gestures serve similar functions and that they belong to a single control system with Hadar and Butterworth's (1997) theory that iconics (i.e. representational gestures) are related to visual imagery whereas beats (i.e. non representational gestures) are connected to phonological encoding of sentences. According to this later hypothesis of two separate mechanisms underlying the production of gestures (representational vs. non representational), iconics and beats should grow and decline at different rates. Feyereisen and Havard (1999) interviewed younger (M=21, range 18-25) and older (M=70, range 61-80) adults using various questions. Three questions were used to elicit visual imagery (for instance "could you describe a favourite painting or sculpture?"), three other questions were used to elicit motor imagery (for instance "Could you explain how to cover a book or to wrap a box in a paper for a present?") and three questions concerned abstract topics (for instance "Do you think that more women should go into politics?"). Thus subjects were tested in three conditions: a visual imagery condition, a motor imagery condition and an abstract condition.

Results show that gesture production is affected by the content of the message. Questions eliciting motor imagery conducted to a larger amount of representational gestures than other questions which can be explained by some specific influence of mental representation of movements. Representational gestures were also frequent in the visual imagery condition and less frequent in the abstract condition. Thus, representational gestures tended to occur with visual and motoric speech content whereas non representational gestures were associated with more abstract content.

As far as age difference is concerned, it appeared that there was no global age difference. Rather, an age-related decrease was found in the proportion of representational gestures, especially in the visual imagery condition corresponding to an increase in the proportion of beat gestures. Therefore, to some extend, it matches the results obtained by Cohen and Borsoi (1996). However, Feyereisen and Havard (1999) hesitate to conclude that decreased rate of representational gestures indicate a reduced use of visual imagery. The fact that the subjects of Cohen and Borsoi (1996) could look at the objects while they were describing them implies that they did not need to activate visual imagery from memory. Also, the proportion of representational gestures produced by younger and older adults did not differ in the motor imagery condition, only in the visual condition, so that we can suppose that iconic gestures are not exclusively controlled by visual imagery. Then, content analysis of the speech did not show age-related difference in the use of high-imagery words. Feyereisen and Havard (1999) recommend revision of the existing theories by suggesting that age-related variations in the iconic/beat ratio is due to several changes in speech characteristics. Indeed, younger and older adults have been found to use different speech styles (see Feyereisen and Havard, 1999, for a review). Because the size of the vocabulary continues to expand across the life span and because the culture and educational system have changed a lot across the 20th century, there are stylistic variations between younger and older subjects and they may be reflected in the gestural behaviour. McNeill (1992) found that beat gestures often serve metanarrative functions and Feyereisen and Havard (1999) noticed such occurrences in their corpus. They admit that these phenomena might be more frequent in the conversational speech of older subjects. The authors also wonder whether beats could accompany more elaborate forms of language and whether these could be weaker forms of representational gestures. Indeed, iconic gestures were more frequent in the shorter responses of younger subjects. One could hypothesize that throughout the life span, iconic gestures are gradually being replaced by beat gestures along with the development of speech and that this process begins during childhood. This hypothesis would support McNeill's theory of a single mechanism controlling both the production of representational and non representational gestures. Yet the fact that in the data of Feyereisen and Havard (1999) the production of beats by older subjects did not increase in high imagery condition does not support

this hypothesis. It rather seems that different mechanisms control the production of representational and non representational gestures.

3.2 For further research

There is a lot more to explore on the subject of gesture production and adulthood.

First, the difference between individuals needs further experiments. Studies on co-speech gestures tend to shed light on similarities between subjects, however, we know that there is an important variability between individuals. It could be interesting to give a task (re-tell a story, describe a picture, give directions, explain something…) to subjects and analyse their gestures on the basis of their sex, language proficiency, social origins, professional activity, personality, education, cognitive style, mental health, etc. Parameters to look at would be gesture type, gesture rate, iconicity, rhythm and the use of gesture space, for instance.

Second, gesture production and aging needs to be explored on various bases. First of all, age probably has effect on gestures on a biological basis. Indeed, age-related decline in motor control is due to modifications in the central nervous system, specifically neural reduction of brain regions, the loss of muscle mass that occurs with advanced age (Ketcham and Stelmach, 1977/2001).This decline in motor control has an effect on everyday life as far as practical actions are concerned but it might also have an effect on the production of co-speech gestures.

Then, even if McNeill's theory of gesture and speech being part of a unique integrated system seems to be true for the production of representational gestures (as we have seen both for children and adults), we can still wonder if it is the same for non representational gestures. As Feyereisen and Havard (1999, 169) put it "as elderly speakers have acquired a great expertise in language use, it is worthwhile to further investigate the various ways in which beat gestures may serve their discourse."

Finally, it seems relevant to inquire about how age-related disease (such as Alzheimer's) can affect gesture production. On the one hand, because studies involving subjects suffering from Alzheimer's disease can help us to better understand how gestures are connected to speech. On the other hand, because

knowing more about how patients suffering from Alzheimer's disease produce and understand speech can help us to better communicate with them.

Individuals with Alzheimer's disease present complex and heterogeneous cognitive symptoms including memory, language and communication, perception, attention and executive functions. Communication problems encountered by these individuals are mainly word finding and understanding the spoken language. As far as comprehension is concerned, Pashek and DiVenere (2006) have found that the use of pantomime gestures accompanying commands helped mild to moderate Alzheimer's disease patients to comprehend spoken language. This is relevant information for caretakers who have to communicate with these patients. As far as production is concerned, Glosser *et al.* (1998) found that co-speech gestures produced by Alzheimer patients reveal several parallels with their linguistic productions. The rate of gesturing of these patients does not differ from the one of healthy age-matched controls. However, when looking closer, one can notice similar disturbances in the specificity and clarity of the referential forms used in verbal and gestural channels by patients with Alzheimer's disease (Glosser *et al.*, 1998). Data show that their gestural communications revealed a proportional decline in the use of symbolically more complex gestures such as metaphorics as compared to gestures referring to concrete contents such as deictics and iconics. Significant correlations between the severity of linguistic and conceptual impairments and the degree of impaired gestural clarity have been found. The authors suggest that this is consistent with the hypothesis that gestural and linguistic communications are closely related in terms of their semantic and conceptual characteristics (Glosser *et al.*, 1998: 9).

4 Conclusions

Gesture studies have rapidly developed over the past decades and many studies have been conducted in order to better understand how gesture is produced and what its functions are. In communication, co-speech gestures appear to be relevant not only to provide the listener with additional or redundant information but also to help the speaker to produce their message. Gesture's function on lexical retrieval and on the conceptualisation of verbal messages has been uncovered by several experiments.

Therefore, gesture is widely considered as intimately connected to speech. It even seems that gesture and speech are part of a single integrated system (McNeill, 1992).

Many studies on child's development, both in the acquisition of language and of concepts have highlighted the predominant role of gesture in these dynamic processes. Work on gestures and children is very important in the field of education since it enables us to discover more about the process of learning.

Gesture and aging have not been not much studied. We know very little about how age affects gestures. However, this is a relevant field of study. First of all, because the increasing numbers of elderly adults in occidental societies (aging of the baby boom generation, improvement of medicine and life conditions that have extended life duration, etc.) is changing the composition of our social world. Second, because analysing how gesture evolves with age can improve our knowledge of gestures and of non verbal behaviour in general as well as our knowledge of language. Third, because different age groups need to communicate with each other and it seems relevant to take a look at potential differences in gesturing (as well as in speaking) and find out whether or not it leads to communication problems.

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